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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/711,697	09/30/2004	Ronald G. Filippi	FIS920040188US1	5696
45094	7590	07/06/2006	EXAMINER	
HOFFMAN, WARNICK & D'ALESSANDRO LLC			AU, BAC H	
75 STATE ST			ART UNIT	
14TH FL			PAPER NUMBER	
ALBANY, NY 12207			2822	

DATE MAILED: 07/06/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/711,697	Applicant(s) FILIPPI ET AL.	
	Examiner Bac H. Au	Art Unit 2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 14 April 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Amendment

1. Applicant's amendment filed on April 14, 2006 in which claims 1, 11, and 17 were amended has been entered.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-5, 7, 11-13, 15, 17, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Su (U.S. Pub. 2006/0019482) in view of Cooney (U.S. Pub. 2004/0018714).

Regarding claims 1, 11, and 17, Su [Figs.2-8] discloses a method of forming a gas dielectric structure for a semiconductor structure, the method comprising the steps of:

forming an opening [Fig.3] for semiconductor structure in a dielectric layer [30] on a substrate [10];

depositing a sacrificial layer [50] over the opening;

performing a directional etch on the sacrificial layer to form a sacrificial layer sidewall on the opening [Fig.5; para.26 1-5];

depositing a metal [80] in the opening;
planarizing the metal and the conductive liner [Para.27 lines 1-5];
removing the sacrificial layer sidewall [Para.28 lines 1-4] to form a void [90]; and
depositing a cap layer [100] over the void to form the gas dielectric structure;

performing a dual damascene process to form an opening including at least one wiring opening and at least one via in a dielectric layer on a substrate [Para.33; Su discloses the invention being applicable to damascene processes, including dual damascene. It is inherent in a dual damascene process that wiring opening (trenches) and via are formed.];

performing a via-first dual damascene process to form an opening including at least one wiring opening and at least one via in a dielectric layer on a substrate [Para.33; Su discloses the invention being applicable to damascene processes. It is inherent that this includes a via-first dual damascene process. It is inherent in a dual damascene process that wiring opening (trench) and via are formed];

removing the sacrificial layer sidewall [Para.28 lines 1-4] to form a void [90] that extends along a side of the at least one via.

Su fails to disclose in the method

wherein depositing a sacrificial layer over the opening, such that the sacrificial layer fails to substantially fill the opening;

wherein performing a directional etch on the sacrificial layer to form a sacrificial layer sidewall, the directional etching removes the sacrificial layer only from substantially horizontal surfaces; and

the step of depositing a conductive liner over the opening.

However, Cooney [Figs.17-20] discloses

wherein depositing a sacrificial layer [140] over the opening [150a], such that the sacrificial layer fails to substantially fill the opening;

wherein performing a directional etch on the sacrificial layer to form a sacrificial layer sidewall [141], the directional etching removes the sacrificial layer only from substantially horizontal surfaces [119,131]; and

the step of depositing a conductive liner over the opening prior to depositing the metal layer [Para.70 lines 6-13].

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teachings of Cooney into the method of Su to include wherein depositing a sacrificial layer over the opening, such that the sacrificial layer fails to substantially fill the opening; wherein performing a directional etch on the sacrificial layer to form a sacrificial layer sidewall, the directional etching removes the sacrificial layer only from substantially horizontal surfaces; and the step of depositing a conductive liner over the opening. The ordinary artisan would have been motivated to modify Su in the manner set forth above for at least the purpose of only forming sidewalls with the sacrificial material, and having a seed layer to facilitate the subsequent deposition of the metal layer.

Regarding claims 2-4, 7, 12, 15, and 19, Cooney [Figs.17-21] discloses the method

wherein the opening [149a,b] includes at least one wiring line opening and at least one via;

wherein the void extends along a side of the at least one via [Figs.20-21];

wherein the forming step includes performing a dual damascene process [Para.61 lines 1-4];

wherein the conductive liner includes at least one of the group consisting of: tantalum (Ta), tantalum nitride (TaN), titanium (Ti), titanium nitride (TiN), tungsten (W) and niobium (Nb) [Para.70 lines 6-13].

Regarding claims 5 and 13, Su [Figs.4-5] discloses wherein the forming step includes depositing a hard mask [60], patterning the hard mask and etching the hard mask.

3. Claims 8, 16, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Su and Cooney as applied to claims 1, 11, and 17 above, and further in view of Cowley (U.S. Pub. 2004/0058526).

Regarding claims 8, 16, and 20, Su and Cooney failed to disclose in the method wherein the sacrificial layer includes one of the group consisting of: aluminum (Al), silicon dioxide (SiO₂) and titanium (Ti).

However, Cowley [Figs.2-9] discloses the method wherein the sacrificial layer [34] includes one of the group consisting of: aluminum (Al), silicon dioxide (SiO₂) and titanium (Ti) [Para.27 lines 1-7].

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teachings of Cowley into the method of Su and Cooney to include in the method wherein the sacrificial layer includes one of the group consisting of: aluminum (Al), silicon dioxide (SiO₂) and titanium (Ti). The ordinary artisan would have been motivated to modify Su and Cooney in the manner set forth above for at least the purpose of having a sacrificial layer that also functions as a gettering layer to remove undesirable compounds from the interlevel dielectric [Cowley; para.27 lines 12-16].

4. Claims 6, 14, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Su and Cooney as applied to claims 1, 11, and 17 above, and further in view of Tsai (U.S. Pub. 2003/0077897).

Regarding claims 6, 14, and 18, Su and Cooney disclose the step of depositing the sacrificial layer, but fail to disclose in the method further comprising the step of depositing a non-conductive liner prior to the step of depositing the sacrificial layer, wherein the non-conductive liner includes one of the group consisting of: silicon nitride (Si₃N₄) and silicon dioxide (SiO₂). However, Tsai [Fig.2c] discloses the method comprising the step of depositing a non-conductive liner [250] prior to the step of

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depositing the sacrificial layer, wherein the non-conductive liner includes one of the group consisting of: silicon nitride (Si_3N_4) and silicon dioxide (SiO_2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teachings of Tsai into the method of Su and Cooney to include in the method further comprising the step of depositing a non-conductive liner prior to the step of depositing the sacrificial layer, wherein the non-conductive liner includes one of the group consisting of: silicon nitride (Si_3N_4) and silicon dioxide (SiO_2). The ordinary artisan would have been motivated to modify Su and Cooney in the manner set forth above for at least the purpose of forming a protective layer to prevent via poisoning in subsequent processing steps [Tsai; para.17].

5. Claims 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Su and Cooney as applied to claim 1 above, and further in view of Te Velde (U.S. Pat. 4561173).

Regarding claims 9-10, Su and Cooney disclose the step of removing the sacrificial sidewall layer by etching, but fail to disclose in the method wherein the removing step includes etching the sacrificial sidewall layer using one of: a) water (H_2O) and sodium hydroxide (NaOH); b) water (H_2O) and hydrofluoric acid (HF); and c) hydrofluoric acid (HF) and hydrochloric acid (HCl); and wherein in the case that water (H_2O) and sodium hydroxide (NaOH) are used as an etchant, the ratio of H_2O to NaOH is no greater than approximately 10:1 and no less than 1:1.

However, Te Velde [Col.6 lines 51-55] discloses the method wherein the removing step includes etching the sacrificial sidewall layer using one of: a) water (H_2O) and sodium hydroxide (NaOH); b) water (H_2O) and hydrofluoric acid (HF); and c) hydrofluoric acid (HF) and hydrochloric acid (HCl); and wherein in the case that water (H_2O) and sodium hydroxide (NaOH) are used as an etchant, the ratio of H_2O to NaOH is no greater than approximately 10:1 and no less than 1:1.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teachings of Te Velde into the method of Su and Cooney to include in the method wherein the removing step includes etching the sacrificial sidewall layer using one of: a) water (H_2O) and sodium hydroxide (NaOH); b) water (H_2O) and hydrofluoric acid (HF); and c) hydrofluoric acid (HF) and hydrochloric acid (HCl); and wherein in the case that water (H_2O) and sodium hydroxide (NaOH) are used as an etchant, the ratio of H_2O to NaOH is no greater than approximately 10:1 and no less than 1:1. The ordinary artisan would have been motivated to modify Su and Cooney in the manner set forth above for at least the purpose of having an effective etchant with desired selectivity.

Response to Arguments

6. Applicant's arguments with respect to claims 1, 11, and 17 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

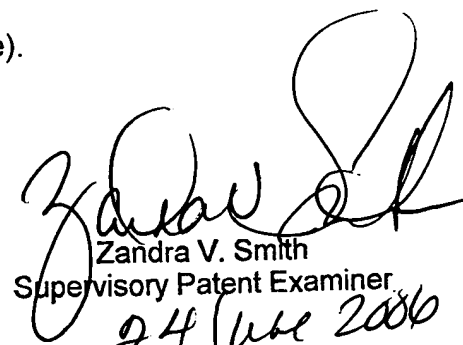
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Bac H. Au whose telephone number is 571-272-8795. The examiner can normally be reached on Mon-Fri 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Zandra Smith can be reached on 571-272-2429. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

BHA



Zandra V. Smith
Supervisory Patent Examiner
24 June 2006